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INTERRELATED ROLES OF THE FEDERAL AGENCIES
AND UNIVERSITIES IN NUCLEAR EDUCATION
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THE ATOMIC ENERGY COMMISSION AND NUCLEAR EDUCATION

Introduction

From its inception in 1946 the Atomic Energy Commission has had a deep interest in nuclear education and has financed a wide variety of education programs, primarily at the graduate level. Aside from the numerous "in-house" educational efforts in nuclear engineering as outlined by Dr. Powers[1/] the first formal major effort was a national pre-doctoral and post-doctoral fellowship program in the basic sciences and engineering. Initially this program was administered by three universities: Columbia University, University of Chicago and University of California; later the administration was transferred to the National Academy of Sciences and, finally, to the Oak Ridge Institute of Nuclear Studies (ORINS). With the establishment of the National Science Foundation Fellowship Program, this broad AEC fellowship was discontinued in June 1952. Since that date the AEC has confined its fellowships to a series of special fields: (1) Nuclear Science and Engineering, (2) Health Physics, (3) Industrial Hygiene, (4) Industrial Medicine, and (5) the Oak Ridge Graduate Fellowships. A program, AEC Graduate Laboratory Fellowships, using the Oak Ridge Graduate

1/ Dr. Philip N. Powers, Head, Department of Nuclear Engineering, Purdue University

DISCLAIMER

Fellowships as a prototype, is now available at a number of AEC laboratories.

A wide variety of university-related programs developed by the Oak Ridge Institute of Nuclear Studies[1/] since it was chartered in 1947 are still active today: the Special Fellowships listed earlier (except the Industrial Medicine program administered by the University of Rochester); the Traveling Lecture Program; faculty participation in the use of Oak Ridge National Laboratory (ORNL) and other Oak Ridge facilities; a Resident Graduate Program for AEC and contractor employees under the academic supervision of the University of Tennessee; Summer Traineeships for college juniors; special seminars; the development of a variety of teaching aids; and an annual symposium or conference on special nuclear topics. The present Gatlinburg Conference is an outgrowth of this last program which began in Oak Ridge in 1949.

Support of university faculty members, other than through laboratory appointments, began in the summer of 1956 with the establishment of the AEC-American Society for Engineering Education (ASEE) Faculty Institute Program. This was followed by a joint AEC-NSF institute program for high school and college faculty in radiation biology, isotope technology and finally radiation in the physical sciences. Also in 1956 - announced at a Gatlinburg University Conference - the AEC started the Equipment Grant Program in the Engineering and Physical Sciences with emphasis on

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1/ The First Ten Years of the Oak Ridge Institute of Nuclear Studies, 1947-1956

reactor technology. This was joined later by Life Science Equipment Grant Program and later an Isotope Technology Grant Program. Thus, the current broad nuclear science education program of the AEC was developed, growing from an initial $1.5 million per year in the original general fellowship program to expenditures during 1963 of approximately $8.2 million. The number of individuals assisted in these programs is impossible to tabulate with any certainty, but 25,000 is probably a conservative estimate. Hopefully, a survey of AEC's educational activities, with empahsis on laboratory programs, will provide a mechanism for having reasonably accurate current figures available.

Simultaneously, other AEC laboratories were being established and they too developed programs of faculty research participation, graduate student thesis programs, summer traineeships, seminars and other activities along the same general lines as those mentioned at ORINS. Each laboratory, of course, reflected its own special nature and capabilities in the development of these programs. Recent developments with educational funds include the broadening of laboratory fellowships and faculty participation on a modest scale to the AEC's Savannah River Laboratory, the Richland Laboratory and the National Reactor Testing Station at Idaho Falls. The University of California is in the process of establishing a Department of Applied Science at the Livermore Laboratories.

In the area of sponsorship of formal schools and courses, the first activity of this type was the Oak Ridge School of Reactor Technology, which had a long history of training Commission and Contractor personnel during the early establishment of Commission facilities. It is still engaged

today in presenting programs in reactor hazards evaluation, and reactor operations supervision for American and foreign programs alike. As the peaceful use of the atom became an instrument of national foreign policy, the International School of Nuclear Science and Engineering was established in 1955 with emphasis on training foreign nationals. This International Institute, as it is called today, plays an important role in cooperative educational activities with the Associated Midwest Universities. In addition to these schools, ORINS administers a variety of courses for special groups of scientists, engineers, medical people and faculty in general.

It should be mentioned at this point that the operation of schools and courses by the AEC at its own sites is under constant review to make certain that the programs we support can be justified as being currently unavailable on university campuses to participants for whom they were designed. We are aware that a group of knowledgeable people, university educators and other interested parties, are examining the ORSORT and International Institute programs to compare these with current university offerings. The Commission welcomes such intellectual inquiries, and is seriously interested in the resulting comments by the committee. We do challenge the entire university community to meet any and all requirements for nuclear education, and will continue to help educational institutions meet these needs.

The Role of the Division of Nuclear Education & Training

The complexity of the many educational activities listed above, combined with the fact that they were originally established by a number of different AEC administrative units has always been confusing to university people and others not directly participating in the programs. For example, the original programs of ORINS were developed under the aegis of the Division of Biology and Medicine. ORSORT and the International School of Nuclear Science and Engineering were established under the Division of Reactor Development. Both of these schools in the last few years have been administered by the Division of International Affairs. The Divisions of Biology and Medicine, Reactor Development and Isotopes Development at one time all had separate Faculty Institute and Equipment Grant Programs, and the first two each sponsored their own Fellowship Programs.

The first step to consolidate these educational activities was taken in 1960 by combining the Reactor Technology programs under the Office of the Coordinator of Nuclear Education and Training. The most recent step, was the formation of the Division of Nuclear Education and Training, effective July 1, 1962, for the first time placing the life science and physical science programs in one office. Effective September 1, 1963, the ORSORT courses will come under DNET sponsorship.

In the paragraph above I touched upon what is perhaps the major role of the newly formed division, to consolidate a variety of educational activities into a cohesive program aimed at supporting and strengthening nuclear science education throughout the nation's educational community.

There are presently twenty-five or so special programs in the current responsibilities of this new Division, counting each Special Fellowship as a separate program. We must examine each and every one of these on a continuing basis relative to their importance now, and their relative importance in the future. Some programs must be dropped, others started. This is not an easy task that we have undertaken, and we solicit the aid of the educational community in examining our program and commenting upon strengths as well as weaknesses. Only in this way can the universities and the AEC work successfully towards a goal of nuclear educational excellence.

Within this broad framework, one problem especially concerns us today, namely, the assessment of the proper role of the AEC facilities - National Laboratories[1/] and many other laboratories - in a cooperative effort. The laboratories have contributed in considerable measure to the development of nuclear education, although their educational role has been a by-product of their major research and development function. From a national, as well as an AEC viewpoint, we contend that neither the country nor the educational community itself can afford the complete loss of the potential educational creativity embodied in the 24,000 or so scientists working for the Commission and its contractors. Conversely, the AEC cannot afford to

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1/ Seaborg, Glenn T.; "Higher Education and the Atomic Energy Commission," Higher Education, U. S. Office of Education, DHEW, December 1961.

remove these same scientists from the stimulating environment of close contact with university faculty and students. We believe a way must be found to maintain and strengthen mutual bonds between these two groupings. We doubt that national laboratories can become universities, we certainly would not recommend the reverse situation. Not only do we believe this, we are obligated to study this whole problem and make recommendations for future Commission action.

These future courses of action must be the result of much discussion by university people, laboratory staffs and other interested parties, with DNET hopefully working as a catalyst to help synthesize a product we think is desired by all.

Another key problem currently under review in our Division is the contributory role the AEC can play in the development of additional centers of educational excellence and the support of the increasing numbers of M.S. and Ph.D. candidates required to meet burgeoning national scientific personnel needs. We are reviewing existing and potential mechanisms for fellowships, training grants and dissertation thesis research. I will discuss this in further detail later.

The Role of the Commission's National Laboratories

What then should be the role of the national laboratories in higher education? Supplementation of universities to be sure, but in what amount and by what means?

In a recent address "On the Interdependence of National Laboratories and Universities"[1/] Chairman, Dr. Glenn T. Seaborg of the AEC stated:

> ". . . . the Atomic Energy Commission is currently spending more than a billion dollars annually on research and development. About $400 million of this amount is spent in the major AEC installations or national laboratories (i.e., Ames, Argonne, Brookhaven, UCLRL, Los Alamos and Oak Ridge) and about $90 million is spent in U. S. universities. The remaining approximately $650 million is spent in the Federal government in non-profit institutions and in industrial organizations. . . . . .
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> "It is not necessary here to belabor the identity of interest of the universities and the Atomic Energy Commission in the pursuit of new knowledge in the microcosmos of atomic and sub-atomic processes. Nor is it necessary to point out. . . . . that the universities and national laboratories are in competition, one with the other, for intellectual excellence and achievement.
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> "In many ways this is a healthy situation. It helps to assure that the goal of excellence is kept clearly before both the universities and the national laboratories. In the competition

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1/ Seaborg, Glenn T.; "On the Interdependence of National Laboratories and Universities," at the dedication of the cyclotron, University of Colorado, Boulder, Colorado, June 23, 1963.

that exists today for top quality manpower, that laboratory or institution which falters or lags behind in its struggle for excellence or pre-eminence rapidly falls further behind due to the "snowball effect." Just as success breeds success, so does failure beget failure. In a period such as this, when we are faced with serious impending manpower shortages of engineers, mathematicians and physical and biological scientists as well as rapidly increasing research costs, it is particularly important that serious thought be given to maintaining our pace of advancement by strengthening our existing centers of excellence, and increasing the level and quality of cooperation between the universities and the national laboratories. In this way, I believe the AEC in concert with the universities and its national laboratories can contribute both directly and indirectly toward meeting the goal of an accelerated rate of training of engineers, mathematicians, and physical and biological scientists."

This statement by Chairman Seaborg challenges the new DNET to find appropriate ways and means of developing the concerted action of our national laboratories and universities.

The Role of AEC in Helping Meet PSAC Goals

The idea expressed by Dr. Seaborg regarding the need for increasing the numbers of centers of excellence in order to meet scientific manpower needs

has been emphasized also by the President's Science Advisory Committee.[1/] The PSAC recognizes four goals of near equal importance. (1) "Increase the number of doctors degrees awarded each year in Engineering, Mathematics and Physical Sciences (EMP) to reach 7500 in 1970; (2) "Increase the number of students who complete a full year of graduate training in EMP to reach 30,000 by 1970; (3) "Encourage the strengthening of existing centers of excellence in EMP and develop new centers of educational excellence; and (4) "Promote wider geographic distribution of centers of educational excellence."

The PSAC points out that the limitations now imposed upon these goals which serve as barriers to graduate education are (1) student motivation - the competition with jobs; (2) faculty shortages; (3) lack of buildings and facilities; and (4) distortion of university activity which can occur when a university undertakes to expand its scientific capability solely with its own resources.

To overcome these limitations the national program recommended by PSAC would provide: (1) adequate financial support for all full-time graduate students in EMP; (2) funds to cover full costs of graduate education in EMP; (3) funds for physical facilities and equipment used; and (4) funds for developing new centers of educational excellence in EMP.

1/ "Meeting Manpower Needs in Science and Technology" President's Science Advisory Committee, Report No. 1, "Graduate Training in Engineering, Mathematics and Physical Sciences," December 12, 1962.

These recommendations of the PSAC are the basis for the President's submission of new educational legislation to the current Congress, as well as budget submissions by various Federal agencies.

The DNET believes that without change in existing AEC legislation, it will be possible to reorient a part of its own educational effort to provide some implementation to the goals of the PSAC.

New Approaches to Old Problems

Viewing the total national needs for more than doubling the numbers of graduate students in engineering, mathematics and physical sciences by 1970, it is immediately apparent that new mechanisms are needed to add to existing fellowship and research support programs in order to search out and then adequately support these additional students. Existing fellowships are certainly not going begging. Both NSF and AEC have more qualified applicants than fellowships; hence, the cream of the crop is skimmed off and the runners-up are much in demand for half-time research assistants, teaching assistants and the like. In the engineering field, a March 1963 report from the Engineering Manpower Commission indicated that only 33 out of 3,160 available engineering fellowships were unfilled, and this was due to very special restrictions which made them difficult to fill. This same report indicated that the engineering deans in 136 institutions offering graduate degrees believed that they could use 6,420 additional fellowships or other means of student support.

In developing new mechanisms, one must examine the various reasons why more graduate students are not enrolled in science and engineering programs. We must examine especially any untapped sources that current programs do not reach. The following portion of my presentation examines these programs and potential additional sources of students and suggests several alternate approaches for attracting and holding these groups of people in graduate science education. These suggestions have considerable merit as national programs as well as being of special interest for the AEC, and we are exploring these potential mechanisms in considerable detail.

There are many factors which deter well qualified individuals from enrolling in graduate science education programs under current support mechanisms. First, according to the already referenced PSAC Report of December 1962, a major reason for terminating science and engineering education at the baccalaureate level has been the lack of student motivation towards advanced degrees and the appeal of the salaries of industrial jobs as they receive their first degrees. Reportedly, a large number of these individuals would like to continue their education but are swayed by the significant difference in industrial salaries as contrasted to continuation of university work. This is especially true in the engineering field where the opportunities at the bachelor's level are frequently greater than those of other fields. Many of these individuals later find that further promotion is quite unlikely unless they obtain more advanced education; yet, the piecemeal approach of evening and week-end courses is a laborious and often discouraging process. Just how many graduate students can be recruited from

well qualified individuals now in industry is unknown, but there are many who believe that several thousand such individuals would return for advanced degrees if more adequate financial support were available.

Secondly, but closely related to the first, is the prevalent social pattern of marriage either before graduation with the first degree or shortly thereafter. This added family responsibility increases the financial contrast between industry employment versus advanced education as mentioned above, and frequently results in a curtailment of further formal education unless the wife finds employment. This latter partial solution in many university towns is quite difficult. Modest fellowship stipends and low dependency allowances usually will not suffice, and these potential students may be lost to graduate science education.

A third loss to graduate education occurs at the high school graduation level and below. Aside from the national merit scholarships there are few, if any, national programs designed to encourage the competent high school student without adequate family support to plan for college work, much less to encourage him to anticipate graduate work. This problem, a part of which is encompassed in the much publicized "dropout problem" category though by no means all, is beyond the reach of the AEC or any federal agency under present legislation so far as a really adequate solution is concerned.

As a partial answer to these problems, we are considering the establishment of a "Nuclear Traineeship Program" which in essence would bear marked resemblance to the existing Training Grant Programs of the NIH, and to a

somewhat lesser degree to the contemplated training grant program of the NSF. The name change is due to the AEC usage of the lump sum contract rather than the grant method of financing such programs.

As is well known, the "training grant mode of support", as urged by the PSAC,[1/] shifts the responsibility for the selection of trainees or fellows from a national selection board to the university approved to conduct a training program. Obviously, the guarantee of quality in this case is not quite the same as with a national selection board. However, if a university approved for such a program has a good graduate school the likelihood of inferior quality students is believed to be quite remote.[2/]

If we are to devise a program which will attract good intellects back into graduate education, when they have been distracted from it by family obligations beyond the reach of present fellowships or for some other good reason, then we must introduce more flexibility to permit their return. Assuming that there are persons who feel that they cannot afford to leave jobs and who are notably capable of superior graduate work, then attracting and holding such persons should ultimately justify any reasonable cost.

There is no one, so far as I know, who will deny that the most vital need for scientific personnel lies at the outer border of knowledge - where

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1/ President's Science Advisory Committee, Report No. 1, op. cit. p. 40.

2/ A university approved for a Nuclear Traineeship Program will probably be selected by a special board of experts.

the limits of present research and theory have taken us, and beyond which we cannot hope to penetrate unless we have the kind of minds which can generate new ideas. Lloyd Berkner puts it this way:[1/]

> "Obviously, the ideas underlying the technology of today are abstruse and highly mathematical in nature. So to comprehend these ideas, and to manipulate the technology born of them intelligently, we require men of very advanced education in substantial numbers. This does not mean a mere 4-year college education, for the ideas involved are at the very boundary of knowledge. The education required is <u>really</u> advanced. Command of the new technology and of the science from which it is derived requires post-graduate education to the doctor's degree and beyond - not less than 8 years beyond the high school diploma. While men of lesser training can be usefully employed in its processes, the creation of new industry, new products and devices, new methods and applications from the new technology arises from the creative and imaginative insights of scientific and technological leaders who have access to the very limits of knowledge."

I repeat, for persons who can accomplish these things, the nation can well afford what it takes to make their advanced education possible. Therefore,

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1/ Berkner, Lloyd V., "Manpower in the Technical Revolution" <u>Civil Service Journal</u>, January-March, 1963, p. 12.

in the AEC Nuclear Traineeship Program now being considered we would recognize the value of appropriate experience by adding an additional sum to the annual stipend normally available for first or second year graduate students. Details of this program have not been formulated, but to be successful in reaching members of the employed group considerable flexibility must be provided.

Toward More Centers of Educational Excellence

Of the 2100 colleges and universities in the United States, 681 offer graduate work (in science, engineering and mathematics,) and 231 offer the Ph.D. degree or equivalent. Thirty-eight per cent of federal research funds are concentrated in 10 universities, 59 per cent in 25 and a total of 90 per cent in 100 institutions.[1/] Federally supported fellowship holders make their choice of universities in about this same distribution pattern. A recent paper by Pettit and Gere indicates, however, that the distribution of graduate degrees granted in engineering does not appear to be nearly as concentrated in a small number of institituions as it appears to be in the research activities.[2/] This is encouraging.

Therefore, in view of the findings and recommendations of the President's Science Advisory Committee (emphasizing the need for

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1/ "The Federal Government and Education," Committee Print, Committee on Education and Labor, 88th Congress, 1st Session, June 1963, p. 49 (words in parenthesis added)

2/ Pettit, J. M. and Gere, J. M. "Evolution of Graduate Education in Engineering," Paper 504.1 ASEE Annual Meeting, June 17-21, 1963, Philadelphia, Pennsylvania

alleviating the shortage of Ph.D's in engineering, mathematics and the physical sciences and the committee's recommendation that this be accomplished by adequate financial support for full time graduate students, the full cost of graduate education to universities, and provision of physical facilities and equipment) we have been consulting with university personnel on methods for implementing the potential AEC role recommended in the program by the President's committee.

Ideas thus far received, reduced to their simplest terms, suggest a program of assistance to promising universities which will allow them to increase both the quantity and quality of graduate education (teaching and research) in the various nuclear disciplines of science and engineering.

Our attention has been directed especially to the belief on the part of some of our university friends that the means and methods by which this is to be accomplished are as important as the fact of assistance itself. Their fear is that some, perhaps several, of our present programs, which were initially most helpful in nuclear science and engineering, may actually be detrimental to the development of these fields on university campuses if they are allowed to expand appreciably. For example, the expansion of our program of AEC Laboratory Fellowships for pre-doctoral thesis research is being viewed in some quarters as separating graduate

on-campus education from research, with detrimental effects on both. Thus it is reasoned that this program may tend to destroy rather than strengthen the scientific and technological competence of universities in the nuclear field.

These comments have been helpful and we, hopefully, will profit from them by giving this program and others our very careful scrutiny. It should be pointed out, however, that the AEC's Laboratory Fellowship Program is designed to supplement universities, not replace them, by making available to universities those things, specialized equipment in particular, which many universities cannot afford to have on campus. The opportunity for the possible misuse of AEC's laboratories for graduate student research is the real basis for these fears. Our advisers' contention is that universities of promise should be provided with the means of supporting such research on campus rather than expanding the use of federal laboratories. This argument is not without its valid points. Some universities might harm their own campus programs by relying too heavily on AEC laboratories. Where there is real faculty strength this result is rather difficult to visualize. For example, the Brookhaven National Laboratory is considered by a group of this country's strongest universities as a valuable adjunct to their nuclear programs and it is used extensively in that manner. Where an AEC laboratory is in close proximity to a university the extensive use of each by the other seems to be a logical and useful development. However, these examples

are, in a sense, special cases and certainly do not totally negate the validity of our critics' opinions. We welcome other comment on this important subject, as we need constructive criticism in all our programs.

Out of these and related considerations has developed a suggested approach which deserves serious study by all interested parties. The attack would combine research project support with fellowship or traineeship programs into a total Federal agency commitment to a few carefully selected universities where the probability of creating additional centers of excellence is above average. In the case of the AEC, we could support nuclear research projects at such universities and also provide funds for fellowships or traineeships to qualified students who would conduct their dissertation research on these projects under the guidance and leadership of the faculty members to whom the research contracts were awarded. Similarly, construction and equipment support might also be provided if justified under the terms of the research contract.

Such an over-all approach, it is argued, would provide strength where it belongs and additional centers of educational excellence in the nuclear field should result. Of course, the Commission already has done this same sort of thing on several occasions. For example, consider Iowa State University, the site of the Ames Scientific Laboratory; the University of California, home of the Lawrence Radiation Laboratory; and others. Further consideration of this method of support may be justified under current circumstances and manpower needs. We will continue to explore the

potentiality of this over-all approach to a combination of research and education support, and we earnestly solicit your comments and recommendations.

I have attempted to summarize briefly the history of the development of the formal educational activities of the AEC, as well as the past and current role of the AEC laboratories in helping support university needs; to illustrate the significance of the establishment of the Division of Nuclear Education and Training, and the major problems that require resolution in its future activities; and, to suggest several solutions to those problems so that the AEC can continue to play a role in meeting the nation's total scientific manpower needs. I thank you.